

# Plug-and-play control: integrating distributed model predictive control in today's industry

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## 1 Introduction

Nowadays industrial processes, manufacturing systems and traffic networks consist increasingly of multiple independent yet interacting subsystems. Tackling such a large scale system with a centralised control structure is generally viewed as impractical, inflexible and unsuitable due to the presence of high coupling, constraints, nonlinearity and communication limitations. Hence, several control architectures have been developed and applied over the last four decades [1]. A first and most often applied structure is the decentralised approach where only local control is of importance, i.e. the local regulators have no knowledge of neighbouring regulators. This approach is rarely optimal and might lead to instabilities when the interactions are significant. In order to overcome these issues, one could consider the alternative of higher level control which coordinates the local regulators as with the hierarchical structure. Alas, the higher level control often becomes so complex that its hard to justify the advantages over a fully centralised approach [2]. Consequently the distributed control architecture with exchange of information among local regulators is increasing in popularity. Hereby the effects of the local actions are taken into account at a system-wide level such that the nearly optimal global performance can be achieved.

## 2 Plug-and-play distributed MPC

One of the control techniques which benefits from these developments is the model-based predictive control (MPC). This control methodology uses an online process model to calculate predictions of the future plant output and one or more cost functions in order to optimise future control actions with or without constraints. Due to the above, large-scale systems are more and more regulated using the MPC technique combined with a distributed architecture. In [3] an up-to-date overview of all the different published DMPC topologies is given. Besides the lower computational complexity and communication load w.r.t. the centralised approach, DMPC also allows us to add a plug and play feature to the large-scale system. This is particularly interesting since most large industrial processes are always live systems in the sense that they are subject to constant change in terms of instrumentation (sensors and actuators) and in terms of subsystems that are added or removed [4].

## 3 Goals

In this project we address the problem of scalability of a large scale system while taking into account both the local as the global constraints. Accordingly, this allows flexible adaptations to the large scale system. The ultimate goal is to combine the benefits of adaptive algorithms with that of MPC, leading to increased acceptance in the process industry. The long-term goal can be divided into two main objectives:

1. To develop a constrained DMPC scheme on a laboratory scale application consisting of  $n$  independent yet interacting subsystems. Hereby, stability, robustness and energy efficiency will be the guiding terms during this developing phase.
2. To optimise the obtained DMPC algorithm with a model-adapting property which will be able to obtain the most relevant model parameters from a control-point-of-view. Those essential parameters can vary due to changes in operating point and number of subsystems.

## References

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